Applying Function Composition

1. In a medical process known as angioplasty, doctors insert a catheter into a heart vein (through a large peripheral vein), and inflate a small spherical-shaped balloon on the tip of the catheter. Suppose the radius r of the balloon increases at the constant rate of 0.5 millimeters per second (mm/sec).

   a) If volume of a sphere is $V = \frac{4}{3}\pi r^3$, find the volume of the balloon after 5 seconds and explain your reasoning.

   b) Find the function that produces the volume of the balloon after a given number of seconds.

   c) The balloon is ordinarily inflated to a volume no greater than 400 mm^3. How long would it take to reach 400 mm^3? How did you find your answer?

   d) Find the radius of the balloon in part c, and explain your process

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2. A patient takes a drug. Function $Q(t)$ tells the amount of drug remaining in milligrams after t hours.

t hours	0	1	2	3	4	5
$Q(t)$ mg	250	225	203	182	164	148

This drug has the effect of raising a patient's heart rate. Function $R(q)$ gives the heart rate in beats per minute for a given quantity q (drug level in milligrams).

q mg	0	50	100	150	200	250
$R(q)$ beats per minute	60	70	80	90	100	110

a) What is the patient's heart rate when he/she takes the initial dose of the drug? Explain your reasoning

b) What is the patient's heart rate one hour after he/she takes the drug? Explain your reasoning

c) Estimate $R(Q(5))$ and explain how you estimated it as well as what the result means.

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3. The number of millions of bacteria in a refrigerated food is given by $N(T) = 20T^2 - 80T + 500, \quad 2 \le T \le 14$ where T is the temperature of the food in degrees Celsius. Once food is removed from a refrigerator, the temperature in Celsius is given by $T(t) = 4t + 2, \quad 0 \le t \le 3$ where t is the time in hours.

   a) Find the number of bacteria found in a food after being out of a refrigerator for 1 ½ hours. Explain your reasoning

   b) Create a new function by composing the two functions in a way that makes sense.

   c) Explain what the new composite function tells you, what its input is, and what its output is (including units)

   d) After how many hours will the bacteria count reach 2000 millions?

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4. Let $c(t) = \dfrac{2000}{1 + 0.0009e^{0.09t}}$ be the gross sales in dollars of a coffee stand when the outside temperature is *t* degrees Fahrenheit. Let $p(c) = \dfrac{-1}{2000}(c - 1850)^2 + 1500$ be the profit in dollars of a coffee stand when the sales are *c* dollars.

   a) Determine the profit of the coffee stand when the temperature is 60 ºF and explain your reasoning.

   b) Create a new function by composing the two functions in a way that makes sense.

   c) Explain what the new composite function tells you, what its input is, and what its output is (including units)

   d) The owner of the coffee stand is thinking of closing when the weather is too hot. For what temperatures might it be in his best interest to close and why?

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